

Fig. 1

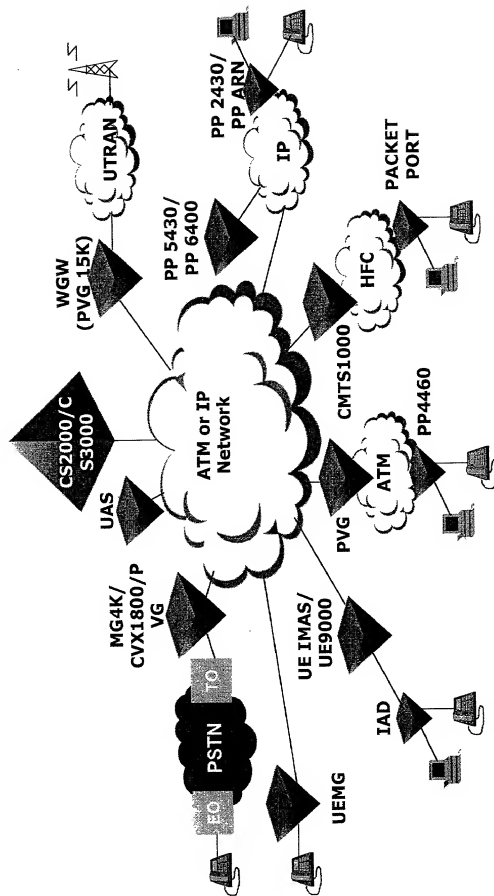


Fig. 2

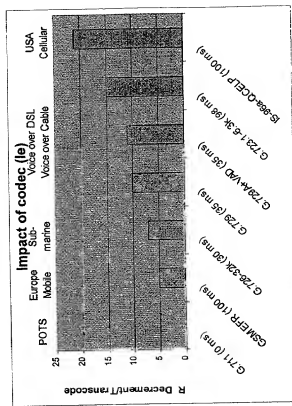
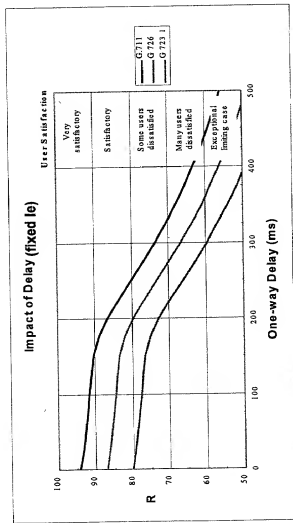


Fig. 3

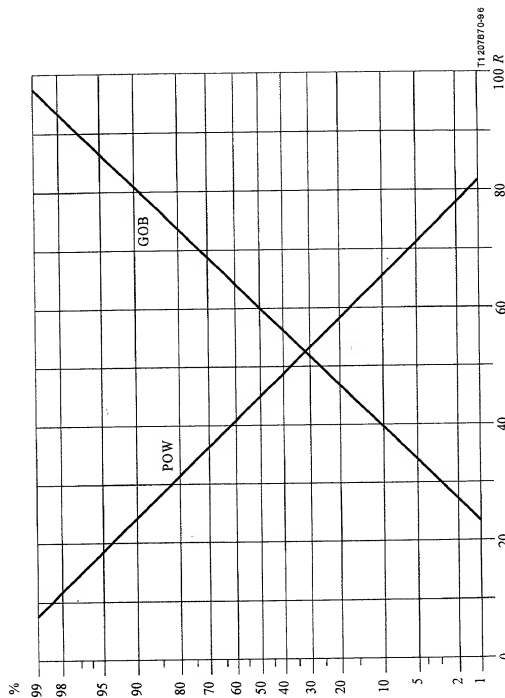


Figure B.1/G.107 - GOB (Good or Better) and POW (Poor or Worse) as functions of rating factor R

Fig. 4

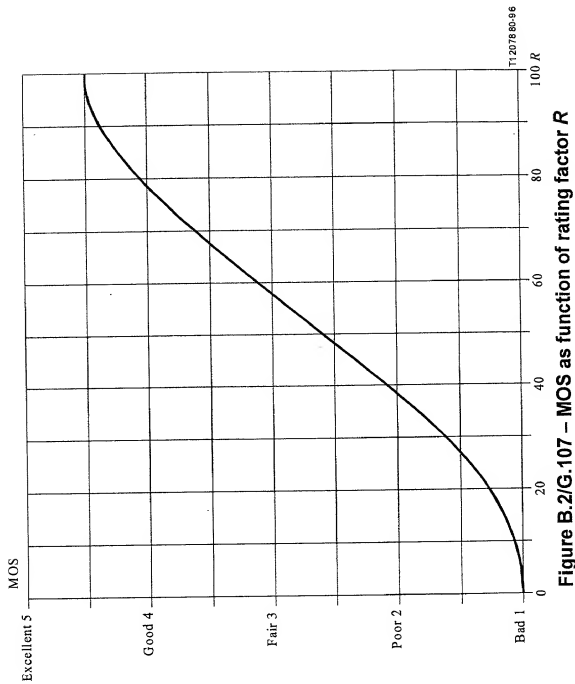


Figure B.2/G.107 – MOS as function of rating factor R

Fig. 5

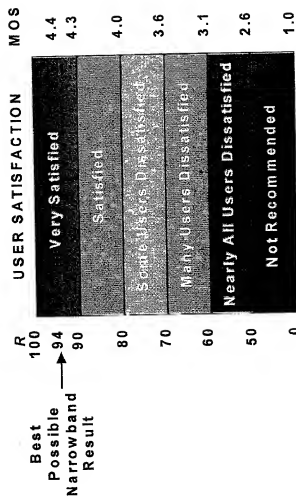


Fig. 6

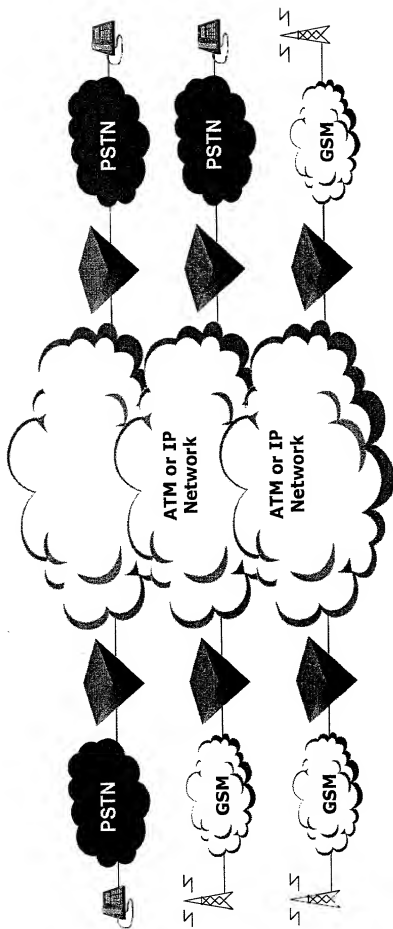
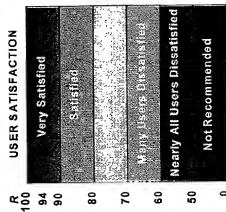


Fig. 7

POTS to POTS (P-P)					
Nat'l		Int'l 0 DCME		Int'l 1 DCME	Int'l 2 DCME
87.8		85.8		76.8	66.6
POTS to Mobile (P-M)					
Nat'l		Int'l 0 DCME		Int'l 1 DCME	Int'l 2 DCME
81.7		70.6		59.8	49.4
Mobile to Mobile (M-M)					
Nat'l		Int'l 0 DCME		Int'l 1 DCME	Int'l 2 DCME
72.7		58.3			39



Mobile is GSM EFR.

POTS is modelled for an analogue set.

Nat'l = 8000km, Int'l = 27500km.

Limit of acceptability - a hard threshold

Fig. 8

What reference calls will be the most demanding quality measure?

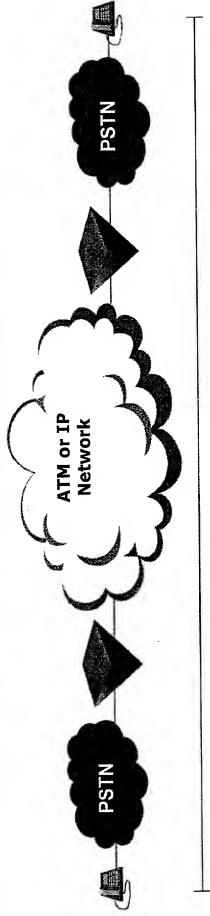


Fig. 9

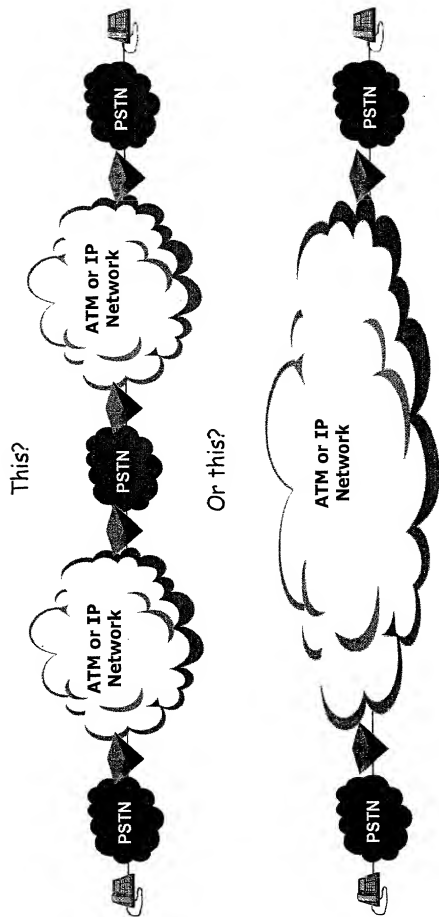
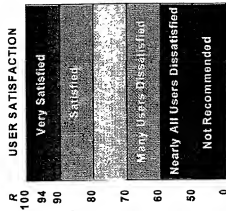


Fig. 10

POTS to POTS (P-P)					
Nat'l		Int'l 0 DCME	Int'l 1 DCME	Int'l 2 DCME	
87.8		86.8	76.8	66.6	
POTS to Mobile (P-M)					
Nat'l		Int'l 0 DCME	Int'l 1 DCME	Int'l 2 DCME	
81.7		70.6	59.8	49.1	
Mobile to Mobile (M-M)					
Nat'l		Int'l 0 DCME	Int'l 1 DCME	Int'l 2 DCME	
72.7		58.3		39	

Limit of acceptability - a hard threshold

Mobile is GSM EFR, POTS is modelled for an analogue set. Nat'l = 8000km, Int'l = 27500km.



(*5R = 0.2 MOS over most of the linear range considered in the statistical noise by many practitioners.)

Fig. 11

POTS to POTS (P-P)					
Nat'l		Int'l 0 DCME		Int'l 1 DCME	Int'l 2 DCME
87.8		85.0		78.8	66.6
POTS to Mobile (P-M)					
Nat'l		Int'l 0 DCME		Int'l 1 DCME	Int'l 2 DCME
81.7		79.5		59.8	49.4
Mobile to Mobile (M-M)					
Nat'l		Int'l 0 DCME		Int'l 1 DCME	Int'l 2 DCME
79.7		58.3			39

Limit of acceptability - a hard threshold

Mobile is GSM EFR, POTS is modelled for an analogue set. Nat'l = 8000km, Int'l = 27500km.

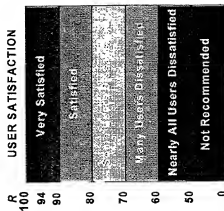
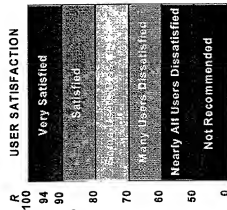
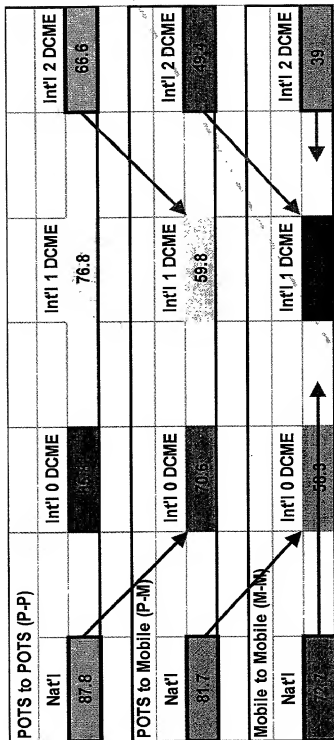


Fig. 12



Mobile is GSM EFR, POTS is modelled for an analogue set. Nat'l = 8000km, Int'l = 27500km.

Limit of acceptability - a hard threshold

Fig. 13

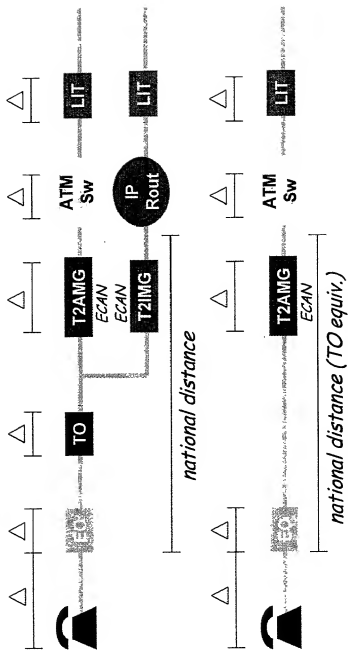


Fig. 14

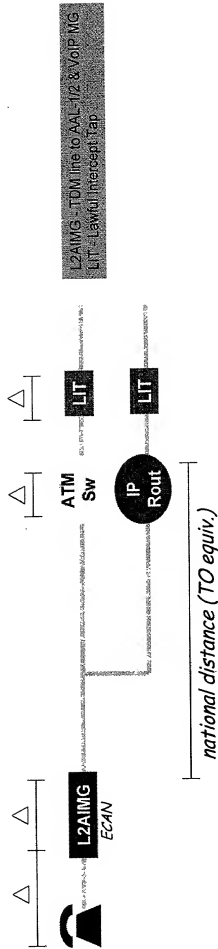
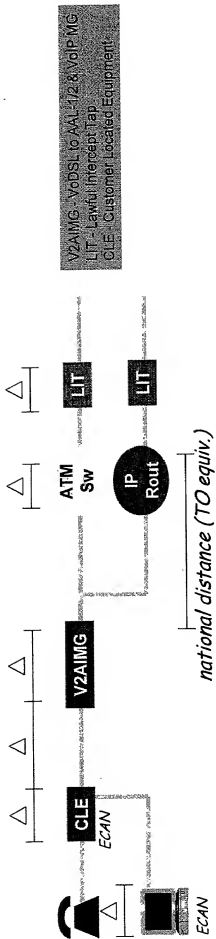


Fig. 15



Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	

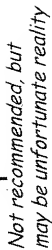
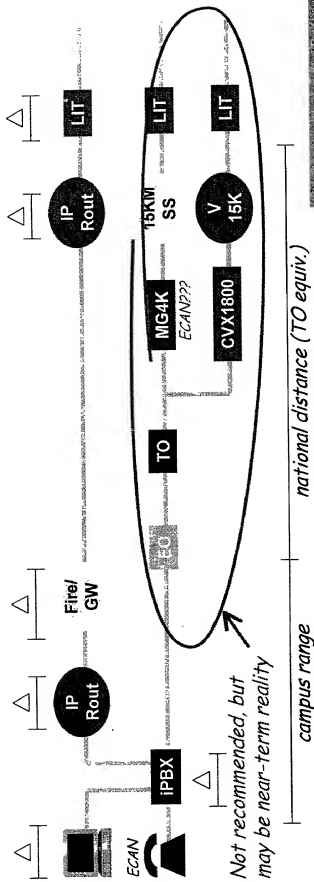


Fig. 17



Not recommended, but
may be near-term reality

Fig. 18

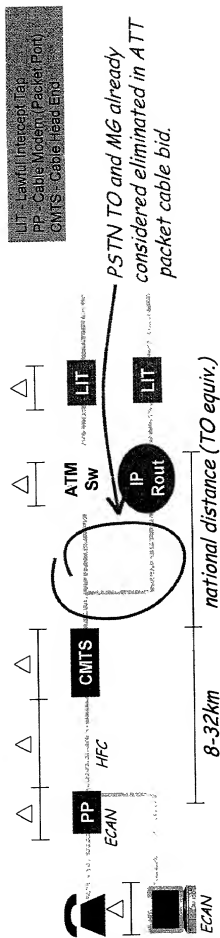


Fig. 19

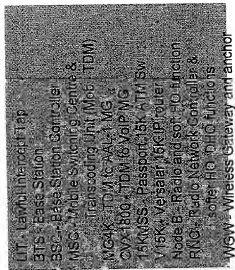
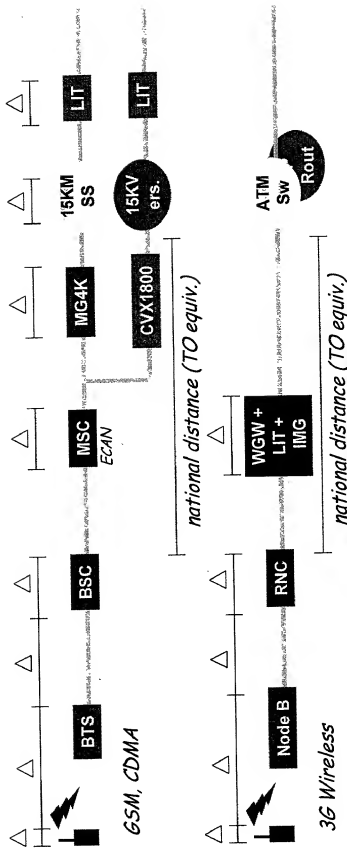


Fig. 20

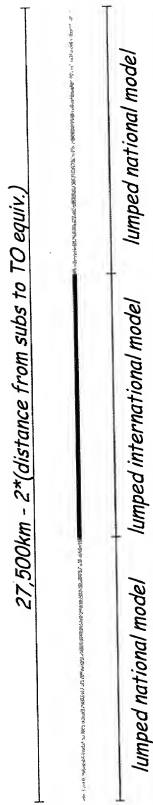
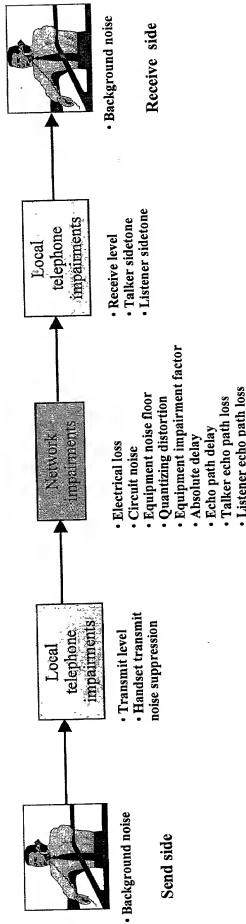


Fig. 21



The E-model calculates a **Transmission Rating Factor R** , given by

$$R = R_0 - I_s - I_d - I_e + A$$

Fig. 22

E-Model Parameter Default Values

Parameter	Units	Value
SLR (Send Loudness Rating)	dB	8
RLR (Receive Loudness Rating)	dB	2
STM (Stidone Masking Rating)	dB	15
LSTR (Listener Stidone Rating)	dB	18
OLR (Overall Loudness Rating)	dB	10
TELR (Talker Echo Loudness Rating)	dB	65
WEPL (Weighted Echo Path Loss)	dB	110
T (Mean Intrinsic One-Way Delay)	msec	0
Ta (Absolute Delay)	msec	0
Tr (Round-Trip Delay)	msec	0
QDU (Quantization Distortion Units)	-	1
Ie (Equipment Impairment Factor)	-	0
A (Expectation Factor)	-	0
Ds (Handset Shape Factor - Send Side)	-	3
Dr (Handset Shape Factor - Receive Side)	-	3
Ps (Room Noise at the Send side)	dB(A)	35
Pr (Room Noise at the Receive side)	dB(A)	35
Nc (Circuit Noise referred to 0 dBr-point)	dBm/0p	-70
Nfor (Noise Floor at the Receive Side)	dBmp	-64

Fig. 23

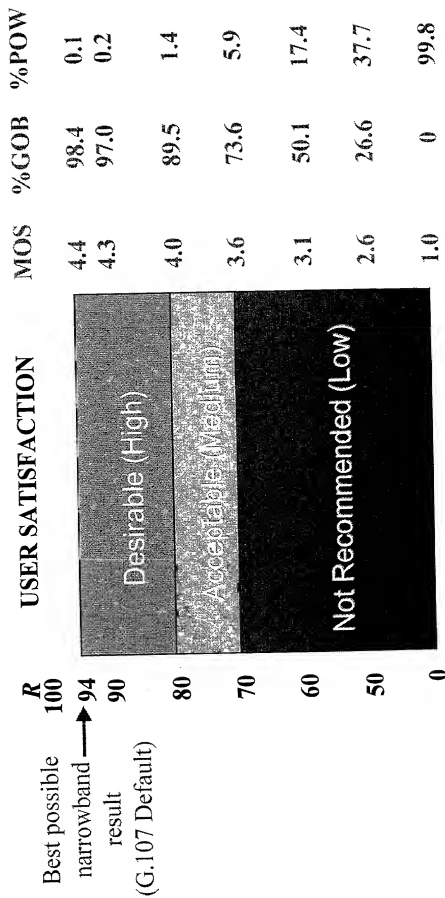


Fig. 24

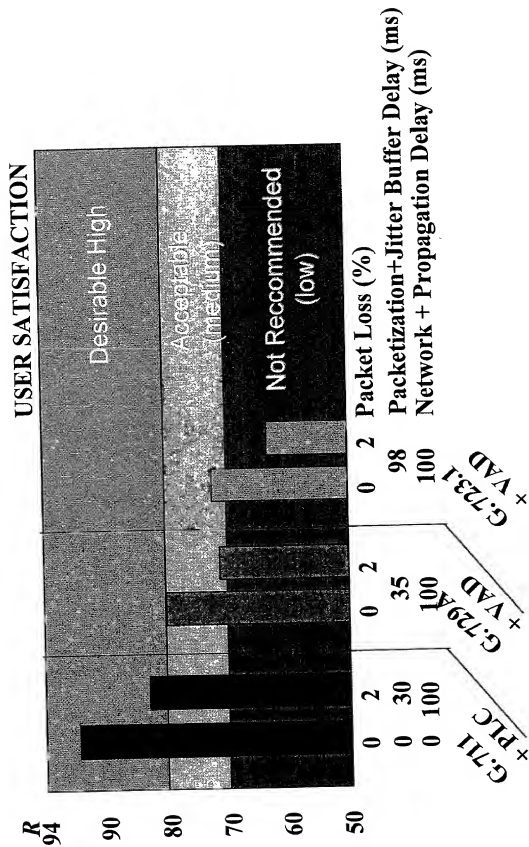


Fig. 25

Table for E-Model Calculations									
	G.711 (Ref.10) (Notes 2, 5)	G.711 (Notes 1, 2, 3)	G.711 (Notes 1, 2, 3)	G.711 (Notes 1, 2, 3, 4)	G.729A (Notes 1, 3) [Note 3]	G.729A (Ref.10) [Note 3]	G.729A (Notes 1, 3)	G.729A (Notes 1, 3)	G.726 32kb/s note [5]
Frame Size (ms)	125	125	125	125	10	10	10	10	125
Packet Payload (ms)	10	20	30	40	10	20	30	40	20
Packet Loss (%)									
0	0	0	0	0	11	11	11	11	7
1	5	8	10	13	13	15	17	19	N/A
2	7	13	16	19	16	19	21	24	N/A
3	10	19	22	24	19	23	25	28	N/A
4	12.5*	22	26	28	22	26	29	32	N/A
5	15	25	30	32	25	29*	32	35	N/A

Notes:

- 1) In the absence of any supporting documentation, these are arbitrary values
- 2) All G.711 vocoders are assumed to have PLC (Packet Loss Concealment) algorithms
- 3) Impairment factors apply for random packet loss conditions
- 4) This is the current capability of the i2004 (in the absence of any download instructions to achieve smaller frame size)
- 5) There is no PLC algorithm for G.726, therefore its deployment might be limited in lossy network
- 6) Interpolated values

Fig. 26

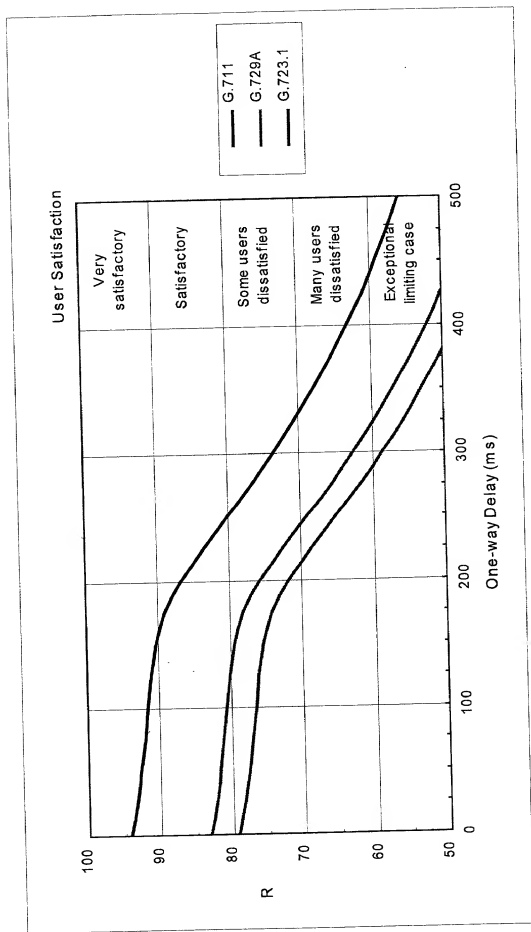


Fig. 27

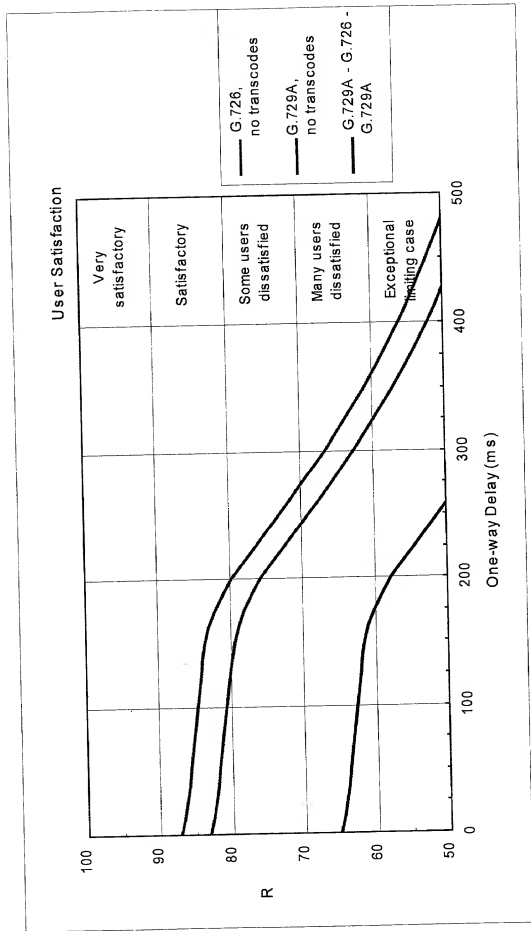


Fig. 28

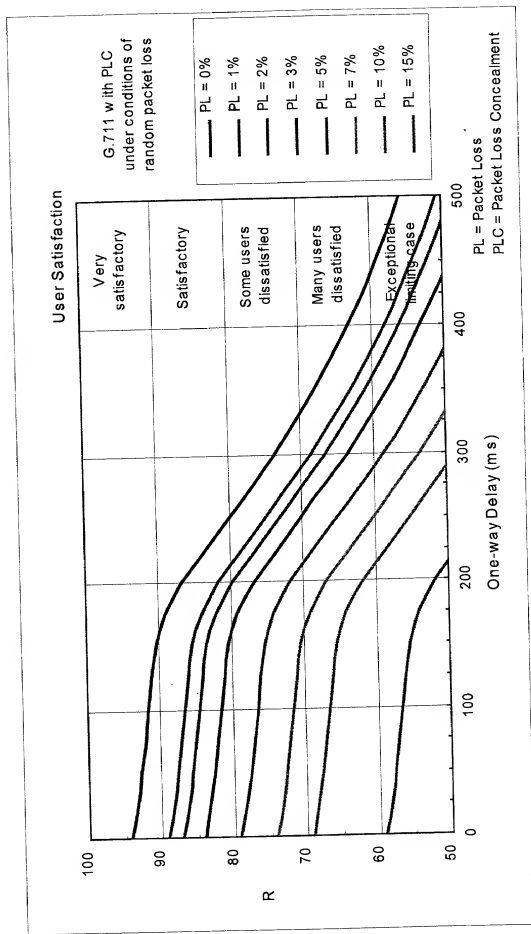


Fig. 29

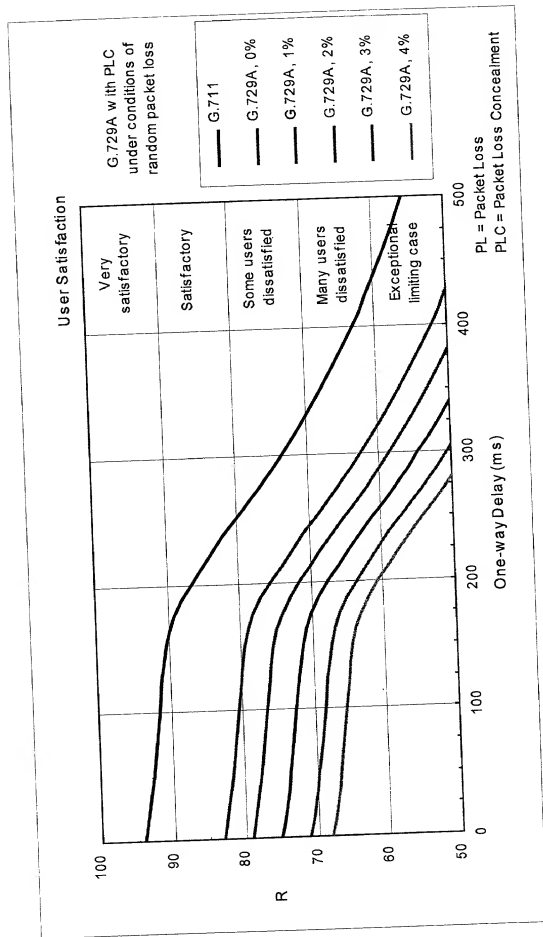


Fig. 30

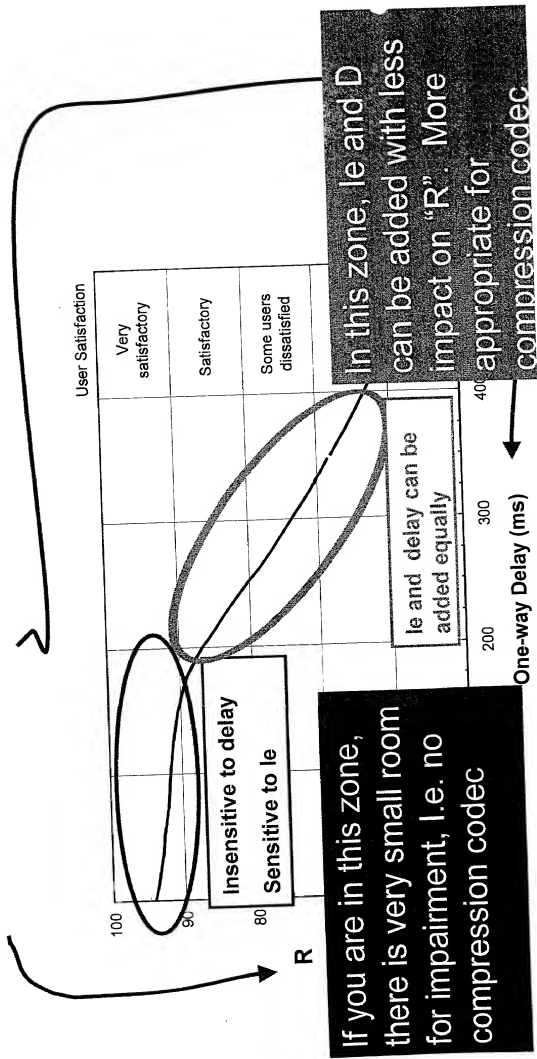


Fig. 31

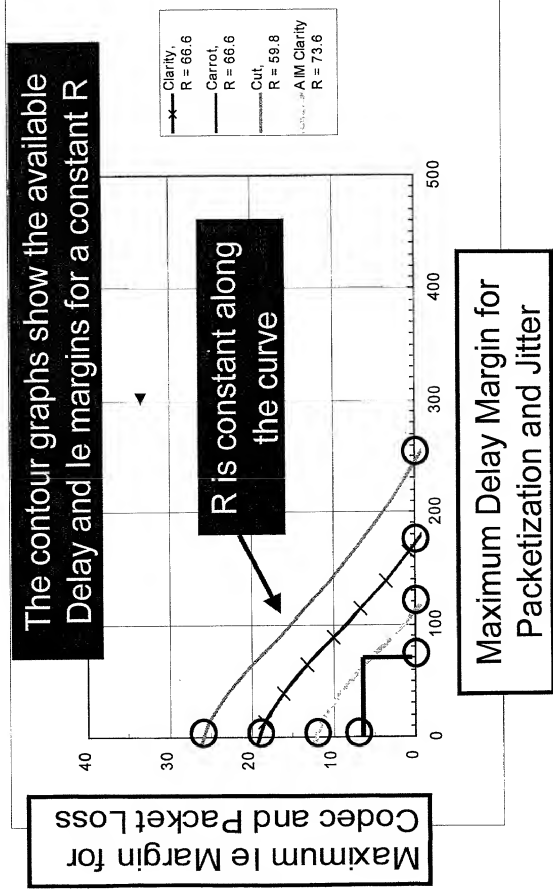


Fig. 32

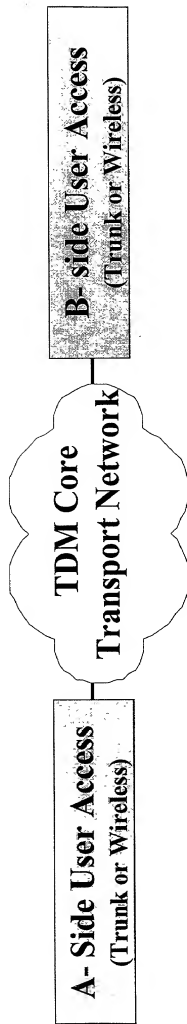
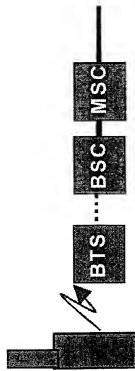


Fig. 33

Title	Abbreviation (Default)	P-Model Input
Electric Circuit Noise (at 0 dB)	Nc (-70 dBmP)	POTS
Room Noise	Po (35 dBA)	35
Send Loudness Rating	SLR (8 dB)	11
Receive Loudness Rating	RLR (2 dB)	3
D-Factor	D (3)	3
Noise Floor	Nfor (-64 dBm0)	-64
Sideline Masking Rating	STMR (15)	15
Equipment Impairment Factor	Ie (0)	0
Expectation (Advantage) Factor	A (0)	0
Mean Intrinsic One-Way Delay (upper)	Tu (0 ms)	0
Mean Intrinsic One-Way Delay (lower)	Tl (0 ms)	0
Mean Intrinsic One-Way Delay	Tul (0 ms)	0
Electrical Loss (upper)	Lu (dB)	0
Electrical Loss (lower)	Ll (dB)	0
Electrical Loss (upper = lower)	Lul (dB)	0
Quantizing Distortion Units (upper)	qduu (1) [Note 1]	0
Quantizing Distortion Units (lower)	qdul (1) [Note 1]	0
Echo Return Loss	ERL (dB)	17



Fig. 34



BTS: Base Station
 BSC: Base Station Controller
 MSC: Mobile Switching Center

PSTN Wireless Access Delay, loss and Impairment Summary		
	Uplink	Downlink
Mobile Switching Center (MSC) (ms)	1	2
Base Station Controller (BSC) (ms)	2.5	40
Base Station (BTS) (ms)	15.8	40.8
Mobile Set (MS) (ms)	72.1	14.3
PSTN Wireless Access Delay (ms)	91.40	97.10
Impairment Factor (Ie)	5	5

Fig. 35

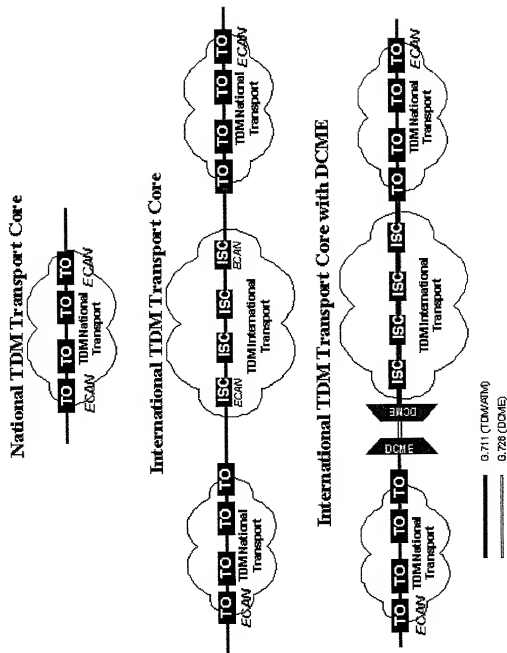


Fig. 36

TDM Core Transport	National (8000km)	International (connection Length 27500 km)		
		0 DCME	1 DCME	2 DCME 3 DCME
National Transmission Time	43	43	43	43
T2DCME (G.711/G.726 Conversion+DSI) (ms)	-	0	26	52
DCME2T (G.726/G.711 Conversion) (ms)	-	0	2	4
International Transmission Time (ms)	-	72	72	72
National Transmission Time	-	43	43	43
Total one-way delay (ms)	43	158	186	214
Impairment Factor (le)	0	0	7	14

Fig. 37

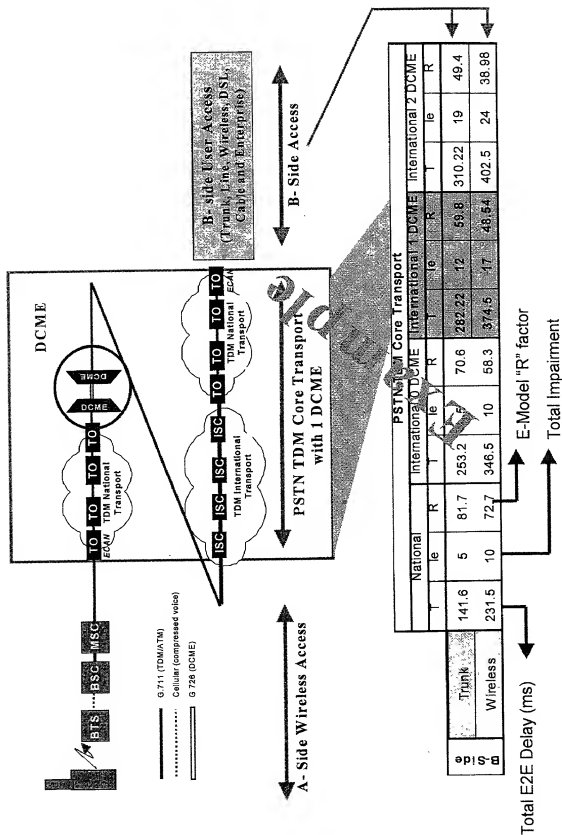
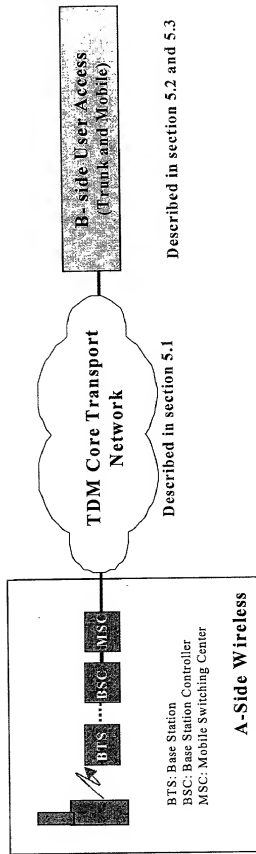


Fig. 39



Described in section 5.1

Described in section 5.2 and 5.3

Wireless Access to	National			International 0 DCME			International 1 DCME			International 2 DCME		
	T	le	R	T	le	R	T	le	R	T	le	R
Trunk	141.6	5	81.7	253.2	5	70.6	282.22	12	59.8	310.22	19	49.4
Wireless	231.5	10	72.7	346.5	10	58.3	374.5	17	48.54	402.5	24	38.98

Fig. 40

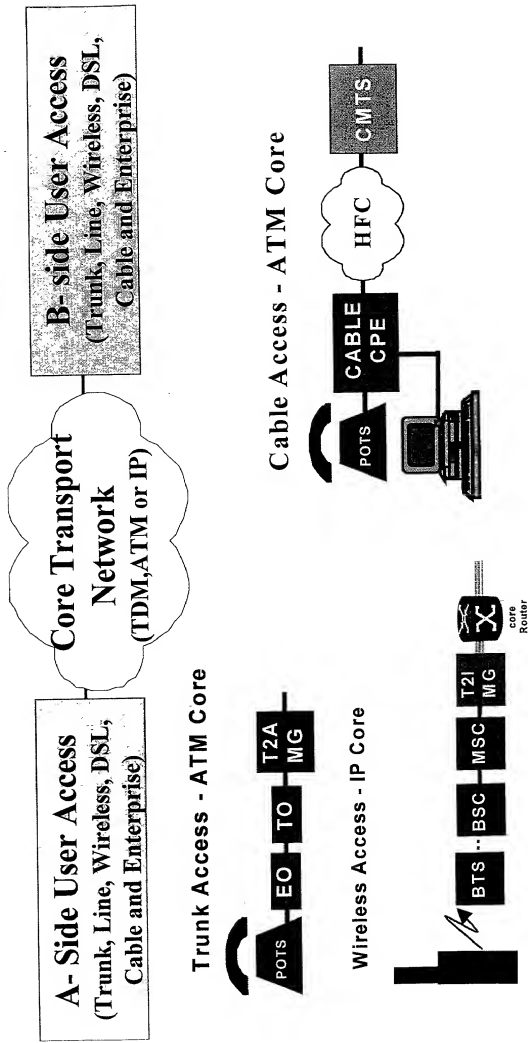


Fig. 41

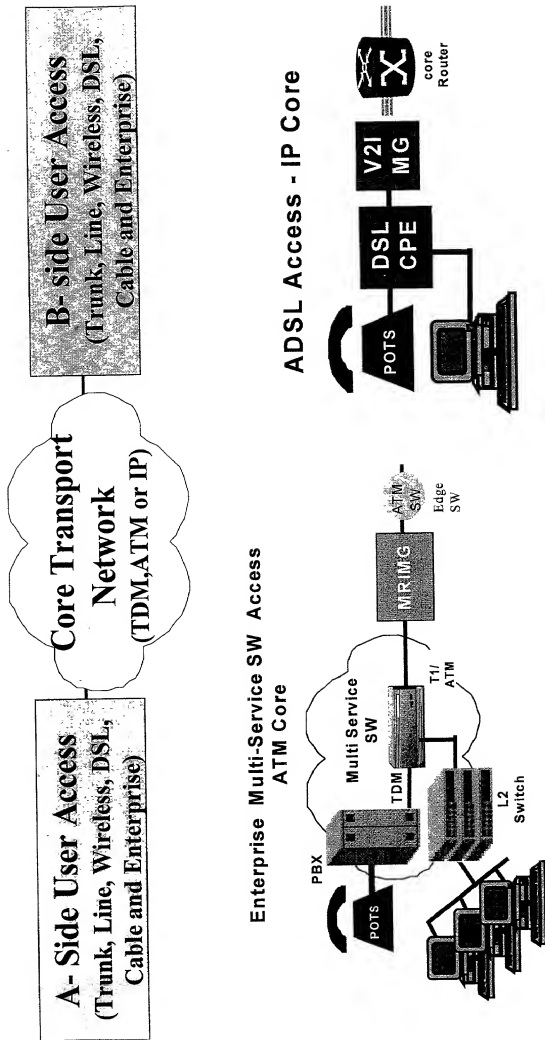


Fig. 42

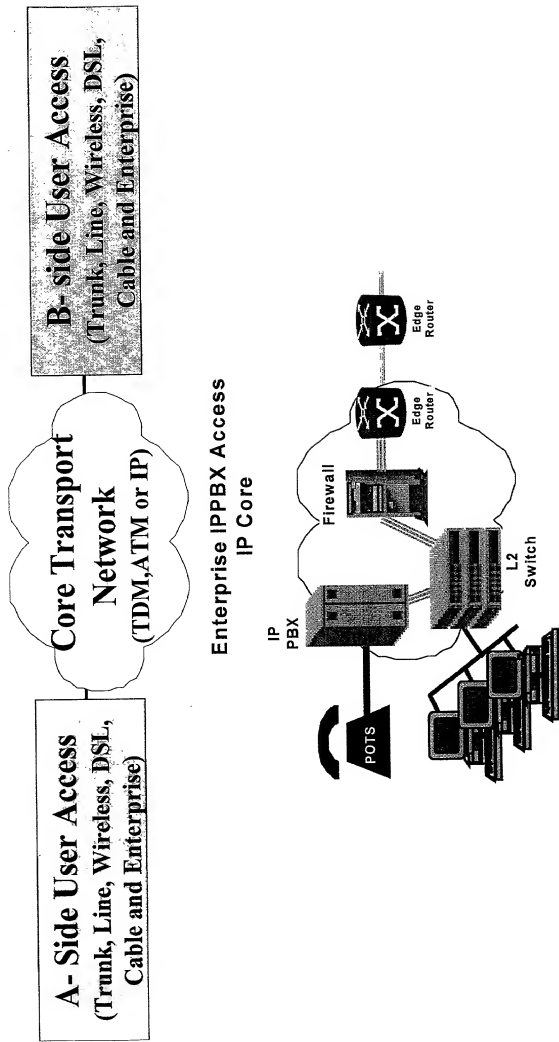


Fig. 43

Which impairments are being considered in the models?

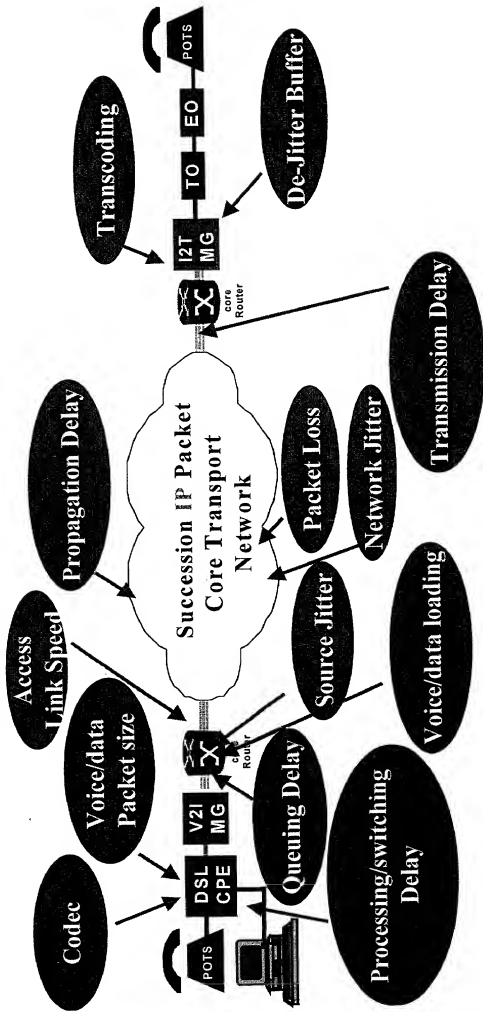


Fig. 44

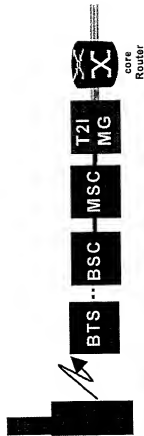
Trunk Access - ATM Core



Trunk Access to ATM Core. (before 4 parameters budget assignment) Delay, loss and Impairment Summary	
Set delay (Side A) (ms)	0
End Office Delay (Side A) (ms)	1.5
Tandem Office Delay (Side A) (ms)	0.75
T2AMG delay (Side A) (ms)	0.5
Trunk Access delay (ms)	2.75
Impairment Factor (Ie)	0

Fig. 45

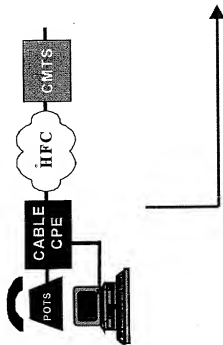
Wireless Access - IP Core



Succession Wireless to ATM Core - Delay, loss and Impairment Summary (before 4 parameters budget assignment)			
	Uplink	Downlink	
Mobile Switching Center (MSC) (ms)	1	2	
Base Station Controller (BSC) (ms)	2.5	40	
Base Station (BTS) (ms)	15.8	40.8	
Mobile Set (MS) (ms)	72.1	14.3	
T2AMG delay (Side A) (ms)	0.5	0.5	
Wireless Access delay (ms)	91.40	97.10	
Impairment Factor (1e)	5	5	

Fig. 46

Cable Access - ATM Core



Cable CPE		Cable CPE		Note
Link Speed	510 Kbps	Upstream	Downstream	
Voice packet size (byte)	180	3000 Kbps	160	note [1]
Voice packet overhead (RTP/UDP/IP)	48		48	note [2]
Data packet size (byte)	512		512	
Data packet overhead	48		48	
Voice packet link utilization (%)	10.0%		10.0%	
Data packet link utilization (%)	90.0%		90.0%	
Fixed Delay				
- Serialization delay for voice packet (ms)	3.26		0.55	note [3]
- DSP & CPU processing delay (ms)	12.00		14.00	note [4]
- Packetization Delay (ms)	0.00		N/A	note [5]
Variable Delay				
- Average Voice data contention (ms)	4.57		0.78	note [6]
- Maximum Voice data contention (ms)	9.15		1.55	note [6]
- De-Jitter buffer delay (ms)	N/A		0.00	note [5]
Other Impairments				
- Packet Loss (%)	0.00		0.00	note [5]
Minimum Delay (Fixed Delays) (ms)				
Average Delay (Fixed+Average Delays) (ms)	15.26		14.55	
Maximum Delay (Fixed+Max Delays) (ms)	19.84		15.33	
Maximum Delay (Fixed+Max Delays) (ms)	24.41		16.11	

Fig. 47

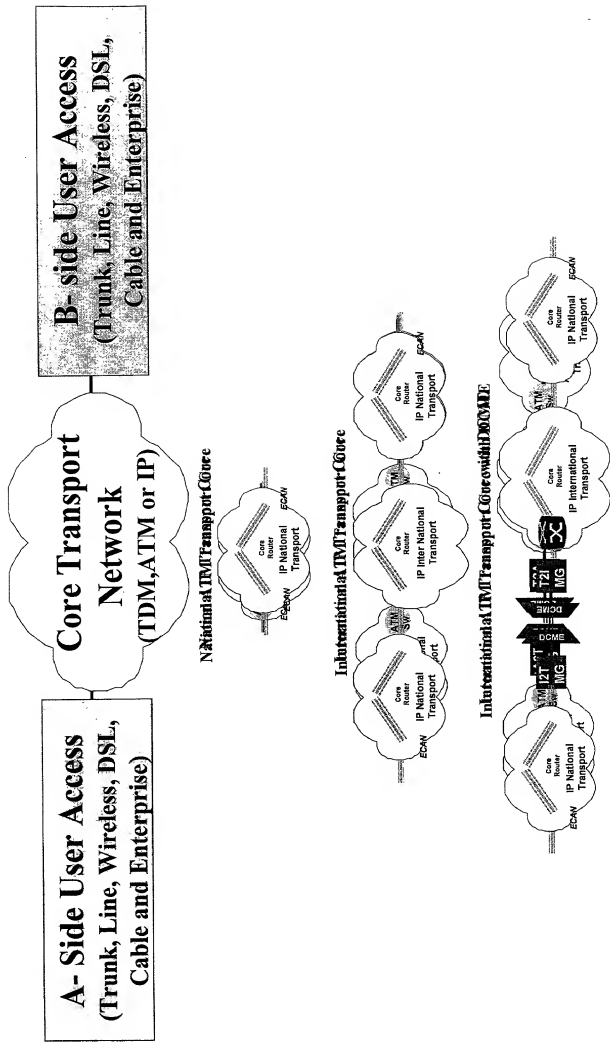


Fig. 48

Total National Transport Distance (km)					Note
	8000 km (P)	8000 km (ATM)	8000 km (TDM)		
Terrestrial Distance (km)	8000	8000	8000		
Terrestrial propagation Delay @ 5us / km (ms)	40	40	40		From G.114
Submarine Distance (km)	-	-	-		
Submarine propagation Delay @ 6us / km (ms)	-	-	-		From G.114
Number of hop	5	8	4		From L356, TIA IS-810 G.114
Equipment processing time (ms)	1ms x 5	0.03ms x 8	0.75ms x 4		
Jitter (ms)	note [1]	1.5 note [3]	0		L356 QoS class 1
Total Delay (ms)	45	41.74	43		Note [2]

Internation Core Transport delay					Note
	27500 (IP)	27500 (ATM)	27500 (TDM)		
Terrestrial Distance (km)	16000	16000	16000		
Terrestrial Delay @ 5us / km (ms)	80	80	80		
Number of hop	15	19	12		From L356, TIA IS-810
Equipment processing time per hop	1	0.03	0.75		G.114
Equipment processing time (ms)	15	0.57	9		G.115
Submarine Distance (km)	11500	11500	11500		
Submarine Delay @ 6us / km (ms)	69	69	69		
Jitter (ms)	note [1]	3	0		L356 QoS class 1
Total Delay (ms)	164	149.57	158		Note [2]

Fig. 49

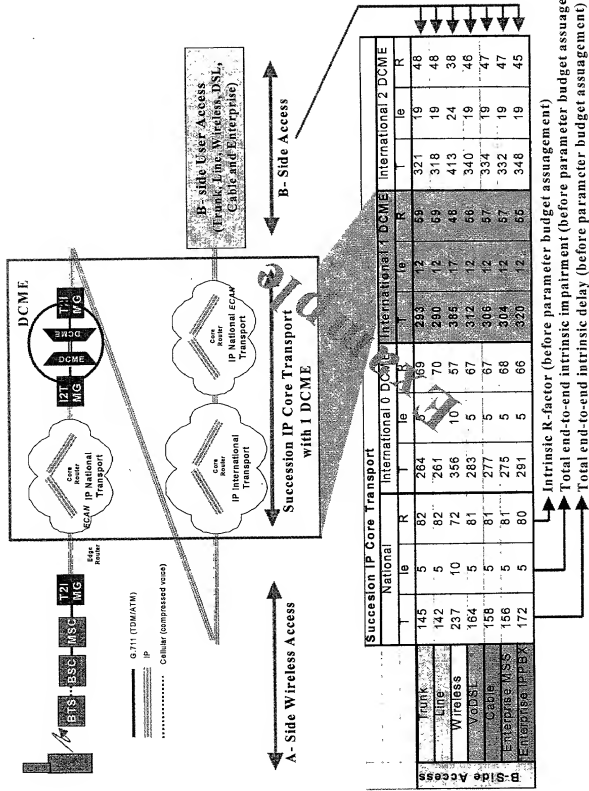
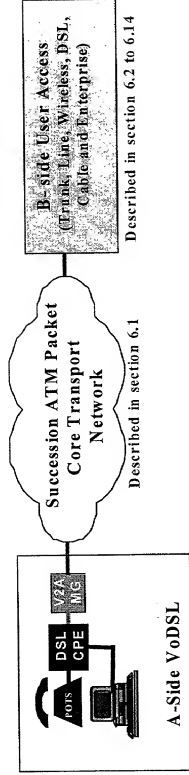


Fig. 50

B-Side Access		ATM Core Transport											
		National			International 0 DCME			International 1 DCME			International 2 DCME		
		I	le	R	I	le	R	I	le	R	I	le	R
POTS Trunk		47	0	88	161	0	86	190	7	77	218	14	67
POTS Line		45	0	88	159	0	86	188	7	77	216	14	67
Wireless		139	5	82	253	5	71	282	12	60	310	19	49
VADSL		66	0	87	180	0	85	209	7	75	237	14	64
Cable		61	0	88	175	0	85	204	7	75	232	14	65
Enterprise MSS		48	0	88	162	0	86	191	7	77	219	14	67
Enterprise IPBX		64	0	88	178	0	85	207	7	75	235	14	64

Note: The four parameters: packetization delay, delay jitter, codec and packet loss have been set to zero. Those four parameters will be determined based upon the available margin. The margin is determined based on the benchmark comparison of an end-to-end Succession network with the closest benchmark representation of existing networks (PSTN only, mobile to PSTN, or mobile to mobile).

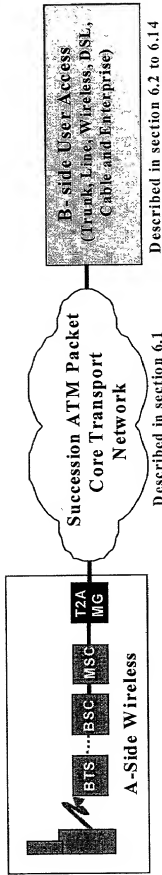
Fig. 51



	ATM Core Transport											
	National				International 0 DCME				International 1 DCME			
	I	le	R		I	le	R		I	le	R	
POTS Trunk	66	0	87	180	0	85	209	7	75	237	14	64
POTS Line	64	0	88	178	0	85	207	7	75	235	14	64
Wireless	158	5	81	272	5	68	301	12	57	329	19	47
VoDSL	86	0	87	200	0	83	229	7	72	257	14	62
Cable	80	0	87	194	0	83	223	7	73	251	14	62
Enterprise MSS	67	0	87	181	0	85	210	7	75	238	14	64
Enterprise IP PBX	84	0	87	198	0	83	227	7	73	255	14	62

Note: The four parameters: packetization delay, delay jitter, codec and packet loss have been set to zero. Those four parameters will be determined based upon the available margin. The margin is determined based on the benchmark comparison of an end-to-end Succession network with the closest benchmark representation of existing networks (PSTN only, mobile to PSTN, or mobile to mobile).

Fig. 52



Described in section 6.2 to 6.14

Described in section 6.1

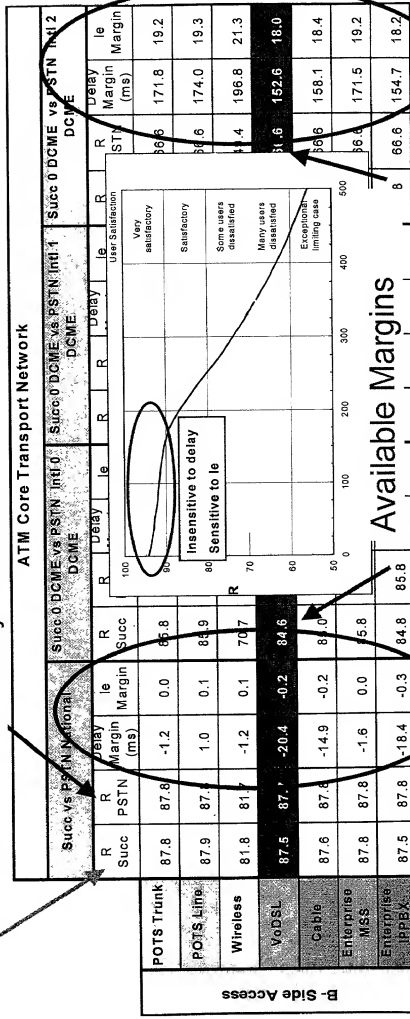
	IP Core Transport											
	National				International 0 DCME				International 1 DCME			
	I	Ie	R	R	I	Ie	R	R	I	Ie	R	R
POTS Trunk	145	5	86	264	5	74	293	12	63	321	19	53
POTS Line	142	5	86	261	5	74	290	12	64	318	19	53
Wireless	237	10	72	356	10	57	385	17	48	413	24	38
VoDSL	164	5	85	283	5	71	312	12	61	340	19	51
Cable	158	5	85	277	5	72	306	12	62	334	19	52
Enterprise MSS	156	5	85	275	5	72	304	12	62	332	19	52
Enterprise IP/PBX	172	5	84	291	5	70	320	12	60	348	19	50

Note: The four parameters: packetization delay, delay jitter, codec and packet loss have been set to zero. Those four parameters will be determined based upon the available margin. The margin is determined based on the benchmark comparison of an end-to-end Succession network with the closest benchmark representation of existing networks (PSTN only, mobile to PSTN, or mobile to mobile).

Fig. 53

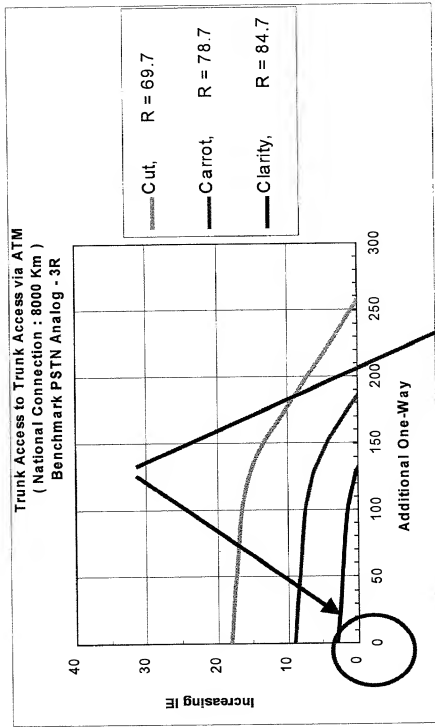
R Succession

R "Clarity" Benchmark



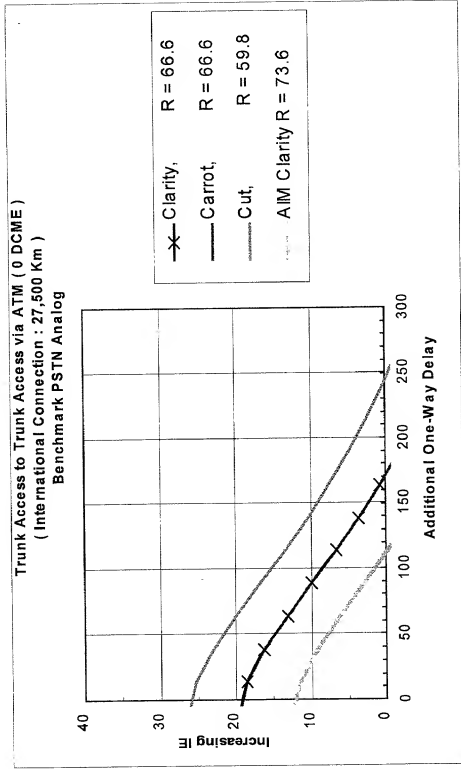
B-Side Access

Fig. 54



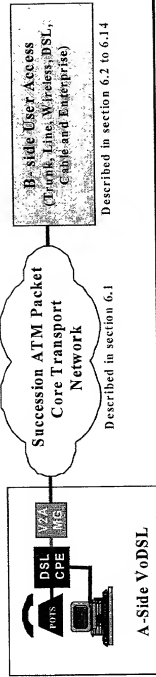
le Budget =	3	9	18
Delay Budget =	130	186	257

Fig. 55



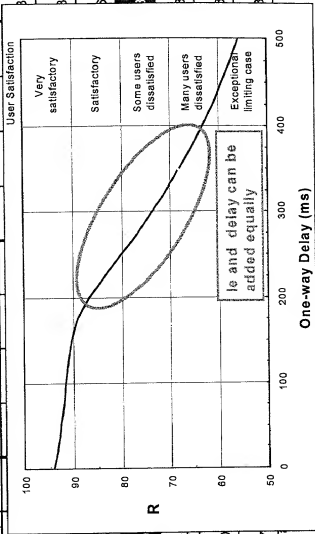
le Budget =	12.07	19.07	19.07	25.87
Delay Budget	110.9	171.5	171.5	244.4

Fig. 56



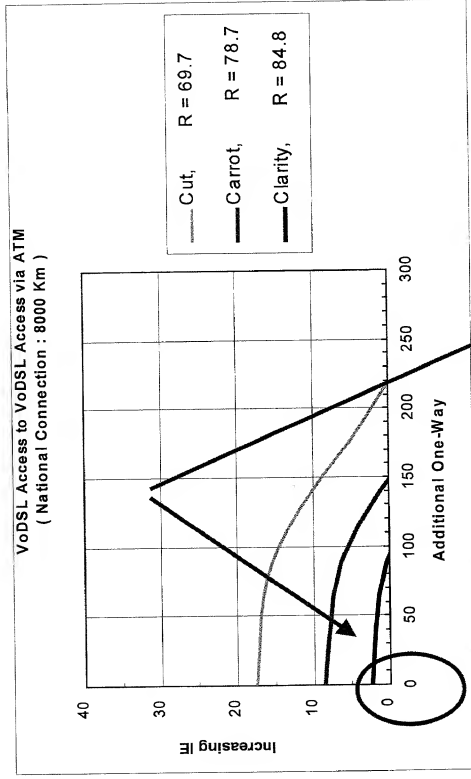
ATM Core Transport Network

Succ vs PSTN National				Succ 0 DCM vs PSTN Intl 0				Succ 0 DCM vs PSTN Intl 1				Succ 0 DCM vs PSTN Intl 2			
R	PSTN	Delay Margin (ms)	le	R	PSTN	Delay Margin (ms)	le	R	PSTN	Delay Margin (ms)	le	R	PSTN	Delay Margin (ms)	le
87.5	87.8	-20										84.6	86.9	152.6	18.0
87.5	87.8	-18										84.8	86.6	154.8	18.2
81.2	81.7	-20										88.1	49.4	177.6	18.7
87.2	87.7	-39										82.8	66.6	133.4	16.2
87.3	87.8	-34										83.4	66.6	138.9	16.8
87.5	87.8	-20										84.6	66.6	152.3	18.0
87.2	87.8	-37										83.0	66.6	135.5	16.4



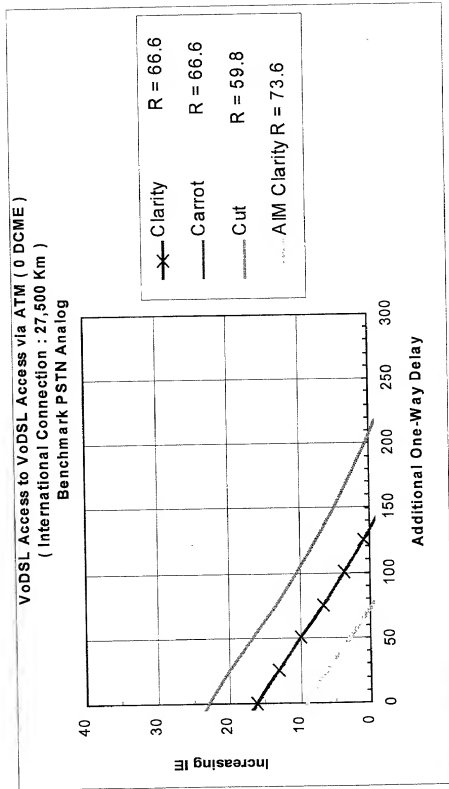
Note: in red indicates the worst case

Fig. 57



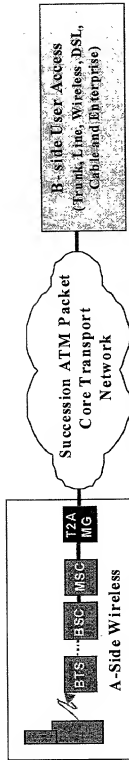
le Budget =	2	8	17
Delay Budget =	92	147	219

Fig. 58



Ie Budget = Delay Budget =	9.207	16.21	16.21	23.01
	72.54	133.1	133.1	206

Fig. 59



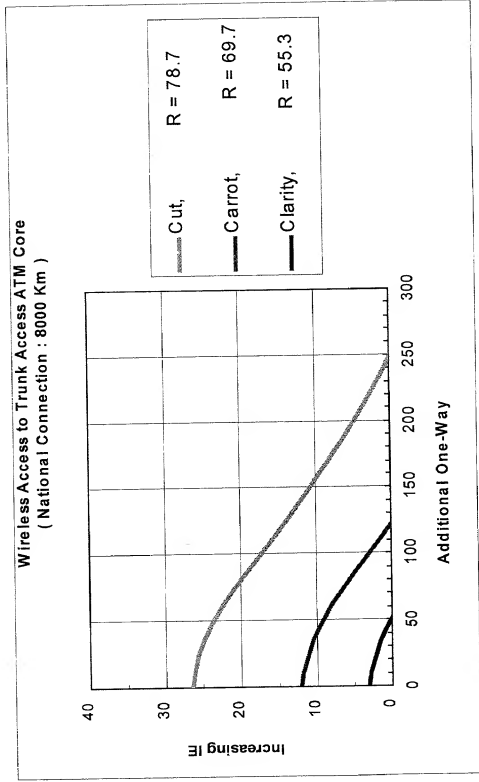
Described in section 6.1

ATM Core Transport Network

Described in section 6.2 to 6.14														
Succ vs PSTN National					Succ 0 DCME vs PSTN Intl 0					Succ 0 DCME vs PSTN Intl 1				
R	R PSTN	Delay Margin (ms)	le Margin		R	R PSTN	Delay Margin (ms)	le Margin		R	R PSTN	Delay Margin (ms)	le Margin	
81.8	81.7	-1.2	0.1		70.7	70.6	-0.2	0.1		70.7	59.8	91.8	10.9	
81.8	81.7	1.0	0.1		71.0	70.6	2.0	0.4		71.0	59.8	94.0	11.2	
72.7	72.7	-0.2	0.0		58.5	58.3	0.8	0.2		58.5	48.5	17.8	10.0	
81.2	81.7	-20.4	-0.5		68.1	70.6	-19.4	-2.5		68.1	59.8	72.6	8.3	
81.4	81.7	-14.9	-0.3		68.8	70.6	-13.9	-1.8		68.8	59.8	78.1	9.0	
81.8	81.7	-1.6	0.1		70.6	70.6	-0.5	0.0		70.6	59.8	91.5	10.8	
81.2	81.7	-18.4	-0.5		68.4	70.6	-17.3	-2.2		68.4	59.8	74.7	8.6	
POTS Trunk					Succ 0 DCME vs PSTN Intl 2					Succ 0 DCME vs PSTN Intl 2				
POTS Line					Succ 0 DCME vs PSTN Intl 2					Succ 0 DCME vs PSTN Intl 2				
Wireless					Succ 0 DCME vs PSTN Intl 2					Succ 0 DCME vs PSTN Intl 2				
VoDSL					Succ 0 DCME vs PSTN Intl 2					Succ 0 DCME vs PSTN Intl 2				
Cable					Succ 0 DCME vs PSTN Intl 2					Succ 0 DCME vs PSTN Intl 2				
Enterprise MSS					Succ 0 DCME vs PSTN Intl 2					Succ 0 DCME vs PSTN Intl 2				
Enterprise IP PBX					Succ 0 DCME vs PSTN Intl 2					Succ 0 DCME vs PSTN Intl 2				

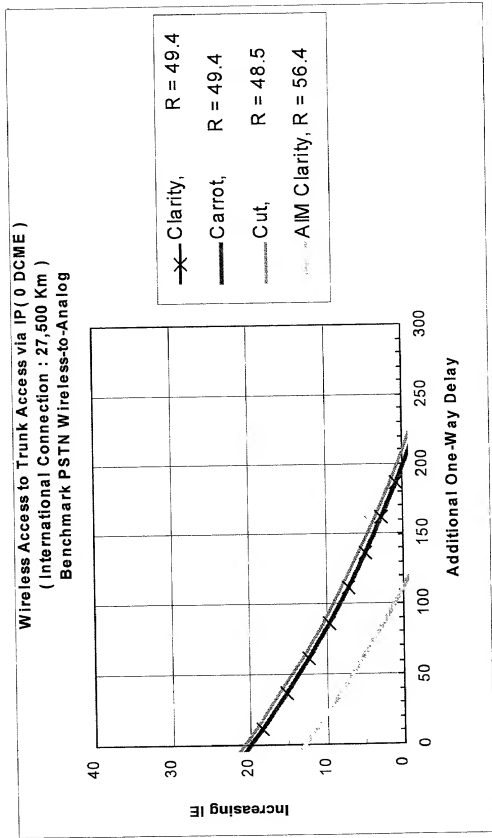
Note: In red indicates the worst case access scenario with the smallest available budget

Fig. 60



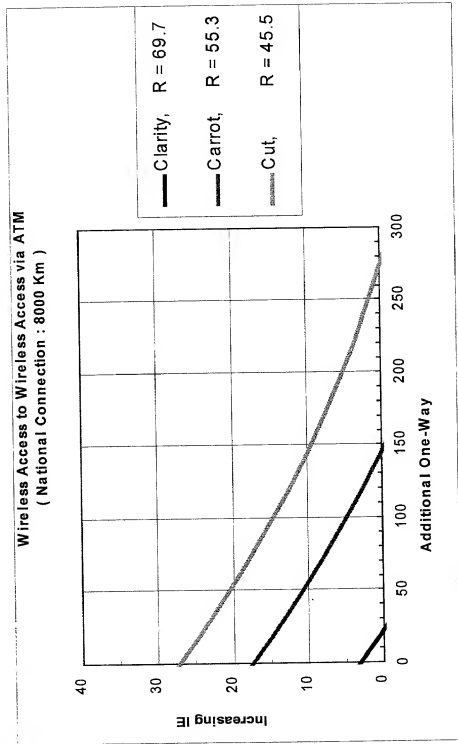
le Budget =	3	12	26
Delay Budget =	51	121	249

Fig. 61



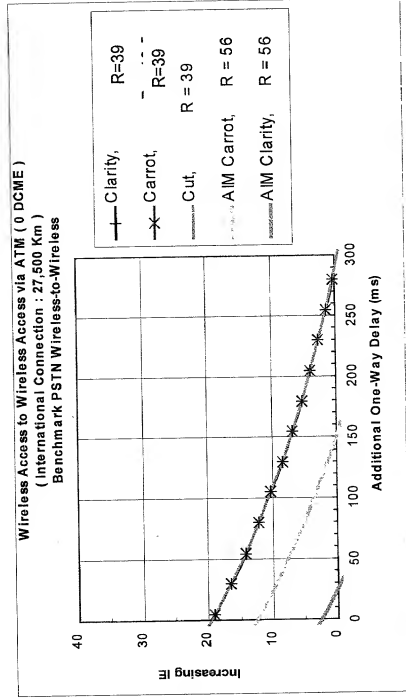
le Budget =	12.91	20	20	21
Delay Budget =	112.4	197	197	210

Fig. 62



Delay Budget =	3.004	17.34	27.14
le Budget =	21.97	145.8	273.1

Fig. 63



le Budget =

2

12

19

19

19

Delay Budget =

25

151

181

248

289

Fig. 64

Rank	Codec	E-model Impairment Factor (1e)	Estimated implementation delay (ms)	Note
1	G.711 at 64 kb/s	0	0.125	PCM
2	G.726 at 32 kb/s with Synch Coding	7	0.250	ADPCM
3	GSM-EFR	5	40	GSM
4	IS-733	*	40	
5	G.728 at 16 kb/s	7	1.250	
6	G.729/G.729A at 8 kb/s	10/11	25	
7	IS-641	6	40	TDMA
8	G.723.1 at 6.3 kb/s (not recommended)	15	30	Soft Phone

Fig. 65

Codec		packetization delay (ms)	max packet loss (%)	le due to packet loss
type	Codec le			
G.711	0	10	0%	0
G.711	0	20	0%	0
G.726(1)	7	10	0%	0

1. This codec is only really suitable for international

Fig. 66

Codec		packetization delay (ms)	max packet loss (%)	le due to packet loss
type	Codec le			
G.711	0	10	0%	0
G.711	0	20	0%	0
G.711	0	40	0%	0
G.726	7	10	0%	0
G.726	7	20	0%	0
G.726	7	40	0%	0
G.711	0	10	1%	5
G.711	0	20	1%	5

Fig. 67

Codec		packetization delay (ms)	max packet loss (%)	le due to packet loss
type	Codec le			
G.711	0	10	0%	0
G.711	0	20	0%	0
G.711	0	40	0%	0
G.726	7	10	0%	0
G.726	7	20	0%	0
G.726	7	40	0%	0
G.729	11	10	0%	0
G.729	11	20	0%	0
G.729	11	40	0%	0
G.711	0	10	1%	5
G.711	0	20	1%	5
G.711	0	40	1%	5
G.726	7	10	1%	2
G.726	7	20	1%	4
G.726	7	40	1%	8
G.729	11	10	1%	2
G.729	11	20	1%	4

Fig. 68

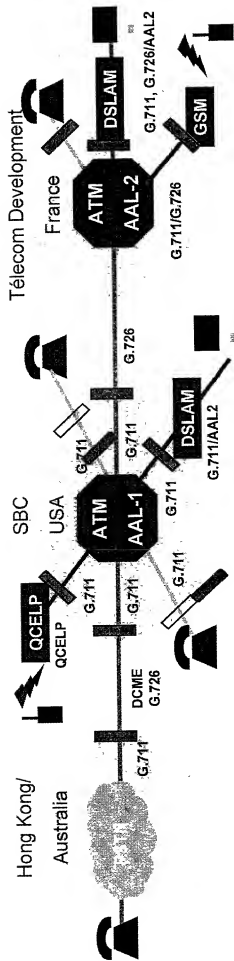


Fig. 69

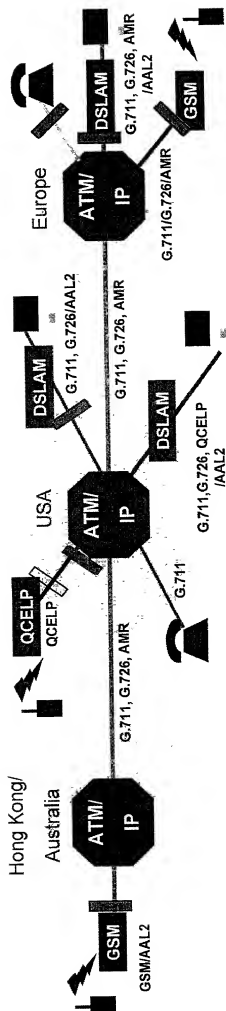


Fig. 70

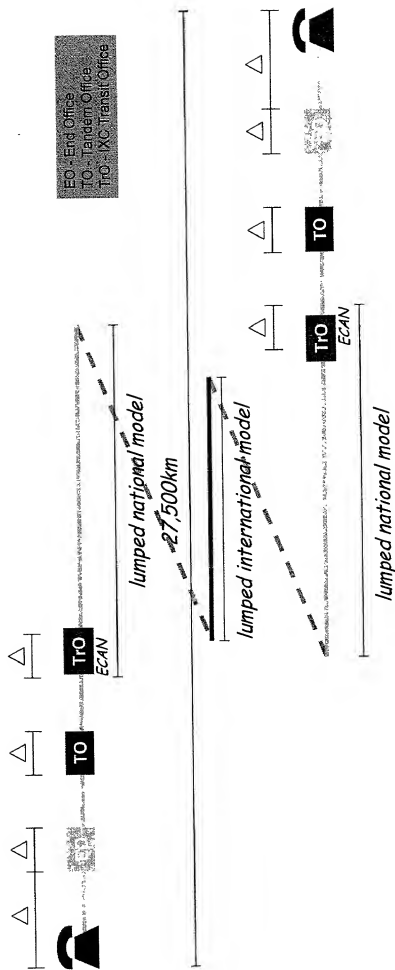


Fig. 71

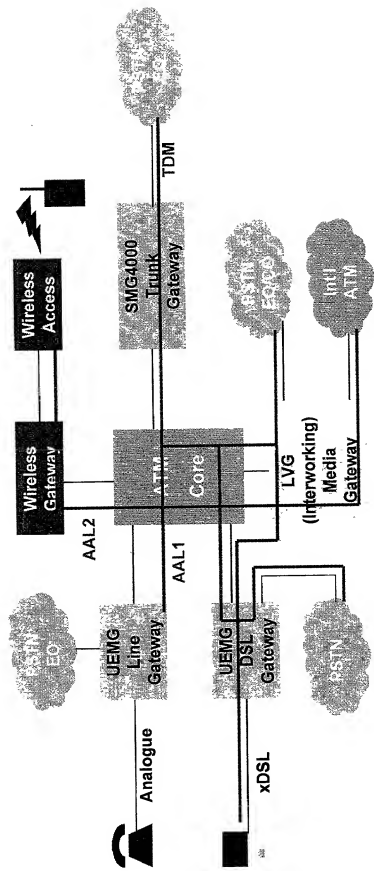
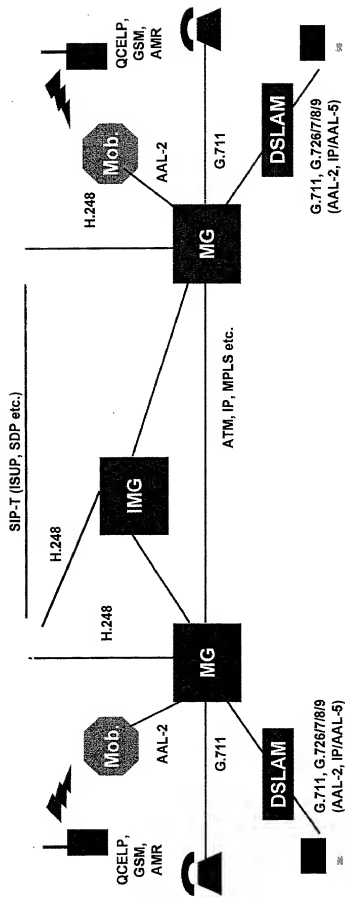


Fig. 72



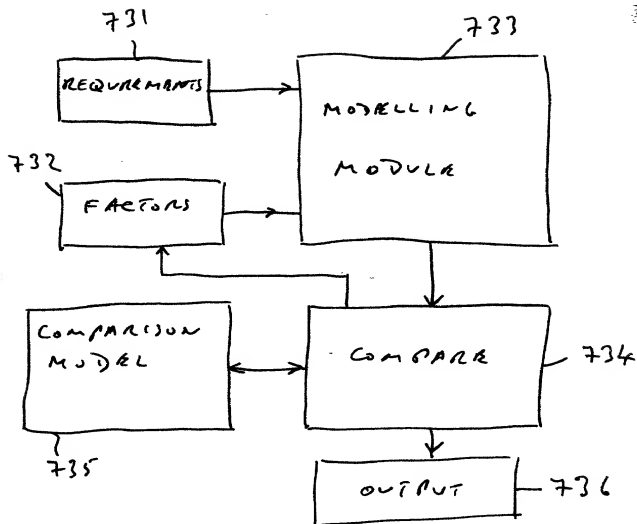


Fig 73